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Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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PARAMETRISATION AND PRACTICAL IMPLEMENTATION OF DEPLOYABLE OPTICAL SYSTEMS

Abstract

The baffling of stray light in optical systems such as star trackers involves structures which can take up significant payload volume which is mostly empty and cannot be used for any other purpose. This leads to highly inefficient packing and can have a large impact on launch costs. Hence, a baffle which is stowed during launch and deployed in-orbit can save on the unused volume. Cable-driven systems offer the opportunity for simplicity while a passive drive mechanism allows for constant tensioning of the cables to maintain structural rigidity throughout the mission lifetime.

In previous work, the design of a cable-driven deployable telescope was presented, the cable being routed within the concentric cylindrical walls of the telescope and the positional accuracy of the optical elements maintained by the cable tension and ball-and-groove locating features. The proposed drive mechanism was envisaged to be a COTS constant torque spring which was sufficiently strong to contend with the mass and friction found during terrestrial testing.

In this paper a deployable conical baffle with 3 stages is proposed. While a baffle does not require as precise a deployment as a telescope, the conical sections enclosed within each other present a challenge in parametrization and optimisation of the mechanism. A prototype with large torsion springs was developed to verify the conical profile and geometry to meet the given stray light constraints. Furthermore, the implementation of the drive mechanism is studied. A variety of spring-loaded mechanism configurations are explored, addressing concerns like hold-down-and-release, tension-balancing, shock-damping and torque-multiplication. The spring force will need to be controlled before deployment, a compact and reliable solution is developed. The high torque of the spring-loaded mechanism in microgravity could cause a significant level of shock to occur at the end of deployment, so the motion either needs to be damped or the speed of deployment reduced to minimise any negative shock effects on the spacecraft. Speed reduction introduces the opportunity for torque multiplication through gearing, scaling down the required spring size and mass, while increasing the complexity of the mechanism.